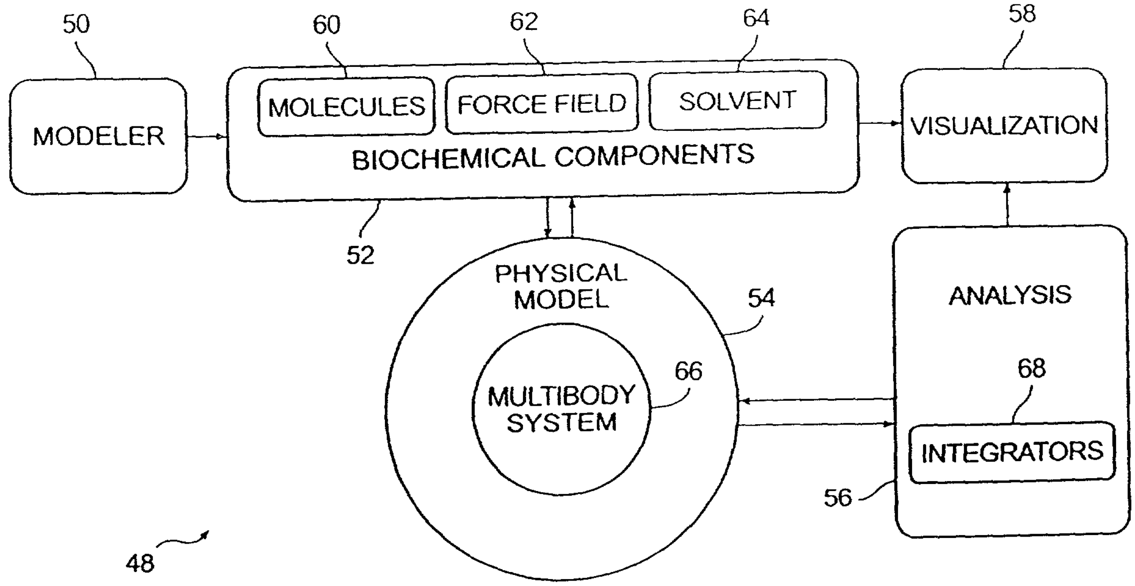
1/4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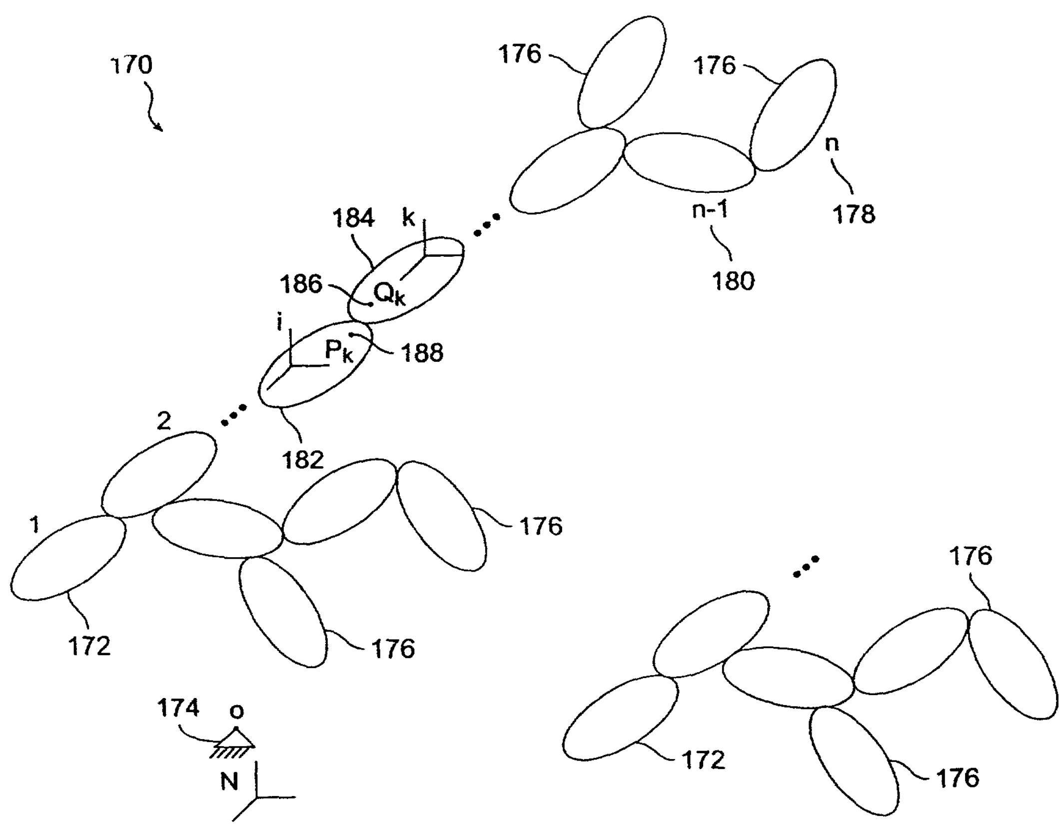
MODELER
60
62
64
MOLECULES
FORCE FIELD
SOLVENT
BIOCHEMICAL COMPONENTS
52
58
VISUALIZATION
PHYSICAL MODEL
54
MULTIBODY SYSTEM
66
ANALYSIS
68
INTEGRATORS
56
48

FIG. 1


170
176
176
n
178
n-1
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184
k
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o
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176
172
176

FIG. 2

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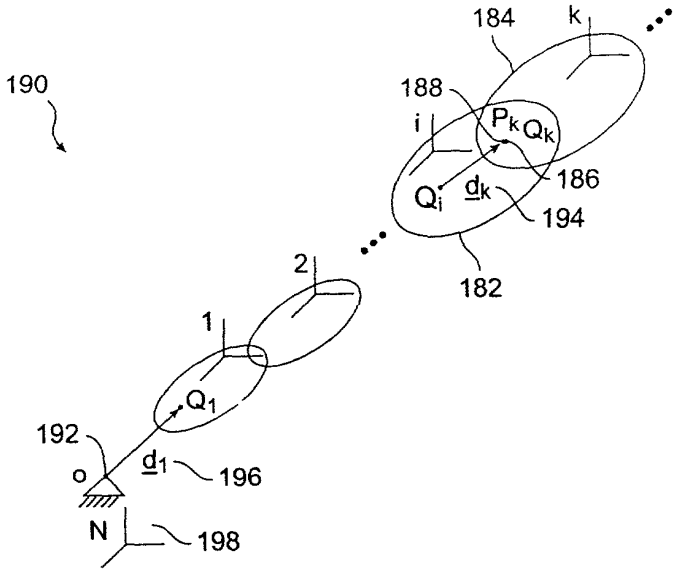

FIG. 3

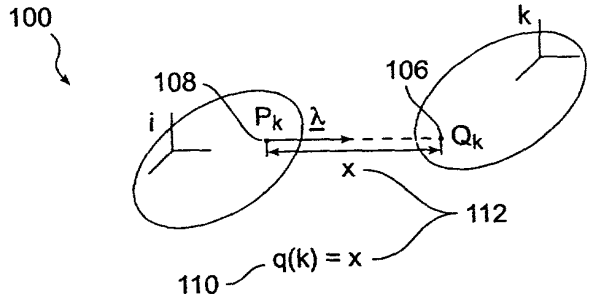

FIG. 4A

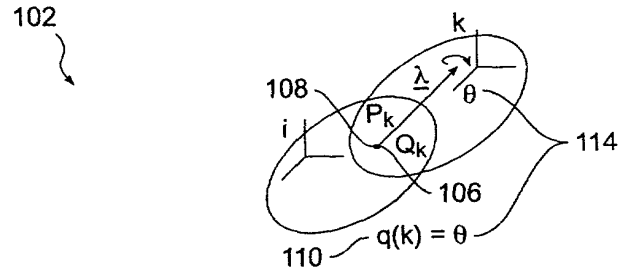

FIG. 4B

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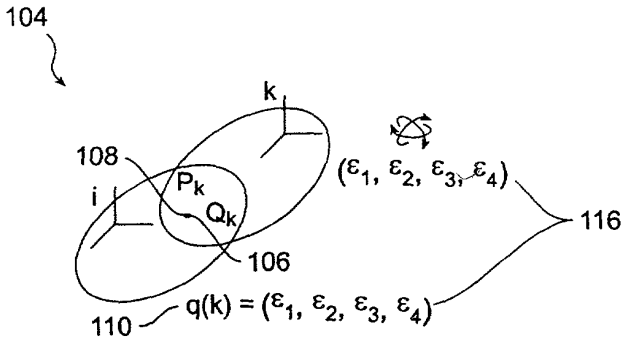

FIG. 4C

RESIDUAL FORM METHOD TO COMPUTE ρ_q AND ρ_u	DIRECT FORM METHOD TO COMPUTE $\dot{q}$ AND $\dot{u}$
1. COMPUTE THE FIRST KINEMATICS CALC. AND THE FIRST KINEMATIC RESIDUAL $\rho_q(k)$ 2. GENERATE $\hat{T}(k)$, THE SPATIAL LOAD BALANCE FOR EACH BODY 3. COMPUTE DYNAMIC RESIDUAL $\rho_u(k)$	1. COMPUTE $\dot{q}$ USING JOINT SPECIFIC ROUTINES 2. PERFORM FIRST KINEMATICS CALC. WITH $\dot{u} = 0$ 3. GENERATE RESIDUALS ρ_u AND NEGATE $\rho_u = -\rho_u$ 4. PERFORM SECOND KINEMATICS CALC. 5. COMPUTE $\dot{u}$ USING FORWARD DYNAMICS

COMPARISON OF METHODS

FIG. 5

ANALYTIC JACOBIAN METHOD

1. COMPUTE THE ANALYTIC JACOBIANS OF THE KINEMATICS ROUTINES:

$$J_{qq} = \frac{\partial(Wu)}{\partial q} \text{ AND } J_{qu} = W$$

2. COMPUTE $z \overset{\Delta}{=} -M^{-1}\rho_u(q, u, 0)$ USING THE DIRECT METHOD

3. COMPUTE THE ANALYTIC JACOBIANS OF THE DYNAMICS RESIDUAL ROUTINE

$$\frac{\partial}{\partial q}\rho_u(q, u, z) \text{ AND } \frac{\partial}{\partial u}\rho_u(q, u, z)$$

4. BACKSOLVE FOR THE ANALYTIC JACOBIAN OF THE DYNAMICS ROUTINE USING RESULTS FOR z FROM THE SECOND KINEMATICS STEP:

$$J_{uq} = \frac{\partial \dot{u}}{\partial q} = -M^{-1}\frac{\partial \rho_u(q, u, z)}{\partial q} \text{ AND } J_{uu} = \frac{\partial \dot{u}}{\partial u} = -M^{-1}\frac{\partial \rho_u(q, u, z)}{\partial q}$$

FIG. 6

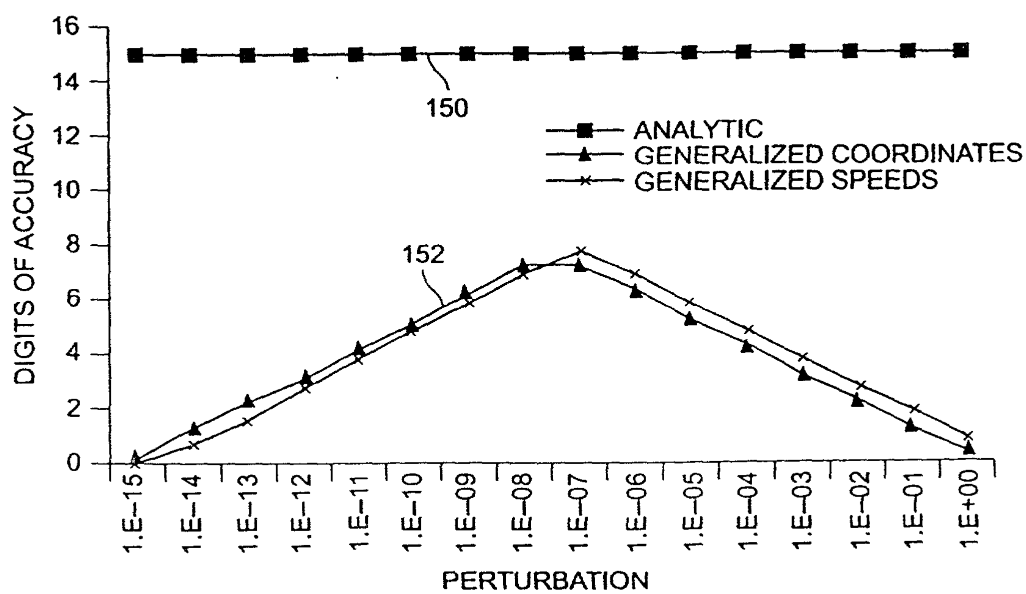

FIG. 7